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EP 0 650 690 B1

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Description

This invention relates to a vacuum cleaner.

Vacuum cleaners having a fan unit driven by an electric motor and placed after the dust bag as seen in the air flow direction, are previously known, see for instance US-A-2272985. According to this arrangement the primary air flow created by the fan unit is arranged to directly or indirectly leave the unit via an outlet to atmosphere. There is also provided first means creating a secondary air flow which at least partly cools the electric motor and which flows into the electric motor via one or several inlets which are separated from the primary air flow.

Vacuum cleaners operating with high speed electric motors are described in WO-A-94/15518 and WO-A-94/15519 and mainly have the advantage that they because of the small dimensions of the vacuum source (turbo fan unit), can be manufactured as small hand held appliances which are easy to handle and to store at the same time, as the suction power is on the same level as previously known traditional vacuum cleaners i.e. such having a power demand of 500 - 1.500 W.

Normally, to cool electric motors in conventional vacuum cleaners, see for instance US-A-2531342 or FR-A-811248, the air flow, which is created by the fan and which is used for sucking up particles through the nozzle, is also used to cool the motor. When the particles have been separated from the air in the dust bag and the air has flown through the fan, the air or a part of the air passes outside and through the electric motor before it is exhausted to atmosphere. This method for cooling the electric motor is simple but can not be used in connection with the vacuum cleaners described in the two WO-publications mentioned above since the air which reaches the motor despite the separation of the particles is contaminated and can cause damages of the motor. It is also desirable to use these fast running electric motors for so called wet and dry suction cleaners i.e. such cleaners where the water or cleaning liquids are taken up by the nozzle together with the contaminates, the moisty air flow, if beeing allowed to pass through the motor, in a very short time would damage it. It is further a risk that larger particles or details follow the air flow into the motor if for any reason the dust bag would break and that these particles because of the small dimensions of the motor and the narrow passages in the motor would damage it.

The purpose of this invention is to achieve a device which gives a reliable cooling of the electric motor for a turbo fan unit described in said WO-publications at the high speed wich is used in this connection. This is achieved with a device having the caracteristics mentioned in independent claim 1.

Since the high speed motor because of its small dimensions and hence the concentrated heat emission is sensitive for disturbances in the cooling air flow there is also a risk that the motor is quickly damaged if the cooling air flow should be blocked because the nozzle or air passages to the motor are clogged by dust or larger details. According to the major part of the embodiments of the invention shown below a sufficient cooling of the vacuum cleaner is achieved also if the air flow through the dust bag should be disturbed.

Some embodiments of the invention will now be described with reference to the accompanying drawings in which Fig. 1 in a schematic perspective view shows a vacuum cleaner according to the invention, Fig. 2 is a longitudinal vertical section through the hand held motor housing of the vacuum cleaner, Fig. 3 is a longitudinal vertical section through the turbo fan unit in the motor housing, Fig. 4 shows in the same view as Fig. 3 an alternative embodiment of the turbo fan unit and Fig. 5-7 in the same view show three additional embodiments of the invention.

As appears from Fig. 1 and 2 the vacuum cleaner comprises a hand held motor housing 10 comprising a turbo fan arrangement 11 and a dust bag 12 the motor housing 10 via a tube shaft 13 being connected to a nozzle 14. The motor housing is via a cable 15 connected to a stationary unit 16 which by means of a cable 17 and a plug 18 can be connected to the electric supply system. The stationary unit comprises, with the exception of a cable reel, and additional accessories for the vacuum cleaner also the electronic equipment which is neccessary for running the electric motor. Speed control is made by control means 19 placed on the motor housing.

The motor housing 10 comprises a plastic hood 20 having a handle 21 in which said control means are inserted. The front end of the plastic hood is shaped as a lid 22 with a tube socket 23 to be fastened on the tube shaft 13. The tube socket 23 opens into the dust bag 12 which is surrounded by a shell so that a tube shaped channel 24 is created. The channel continues in the direction towards the rear part of the motor housing via a section 25 with gradually decreasing section area into an inlet 26 for a turbo fan unit 27 which is a part of the turbo fan arrangement 11. The turbo fan unit 27 comprises a shell forming an inlet section 28 with gradually increasing section area and a turbo fan impeller 29 having blades in close vicinity of the section 28. The turbo fan unit 27 also has an outlet 30.

The turbo fan impeller 29 which is a combined axial-radial impeller is fixed on a shaft 31 of an associated electric motor 32 the same shaft also supporting the rotor of the electric motor. The electric motor is driven at a speed which is above 50.000 rpm and which preferably is 70.000 - 120.000 rpm. The stator 34 of the electric motor is surrounded by a motor shell 35 which together with an outer shell part 36 forms an annular passage 37 in which the outlet 30 of the turbo fan unit opens. The rear end of the motor shell 35 is shaped as a cut off tapered sleeve 38 one end of which together with the shell part 36 forms a radial outlet 39 with a filter 40 through which the air flow which the turbo fan unit 27

creates can leave to atmosphere.

The shaft 31 of the electric motor is at each side of the rotor 33 resting in a hub part 41 of the motor shell 35 and the shell has several openings 42, 43 for cooling air placed outside and near the hub part 41. Cooling air which is drawn from an inlet 44 at the outer part of the sleeve 38 is supplied to or withdrawn from the rotor and stator windings of the electric motor by means of a fan 45. This fan for cooling air is a centrifugal fan which is arranged at the rear side of the turbo fan impeller 29 so that the blades of the cooling fan are facing towards the electric motor. The shell of the electric motor forms a fan housing in which the openings 42 are the inlets for the cooling fan whereas the outlet 46 of the fan is placed in close vicinity to the outlet 30 of the turbo fan unit. The cooling fan 45 can of course be a part which is removable from the turbo fan impeller 29 or be integrated with it.

The device described in Fig. 1-3 operates in the following way. By activating the control means 19 the electric motor 32 is started which means that the shaft 31 with the turbo fan impeller 29 and the cooling fan 45 starts to rotate. The turbo fan impeller creates a flow of air which is sucked through the nozzle 14 and which via the tube shaft 13 enters into the dust bag 12 in which the dust particles are separated from the air flow. The air then continues through the channel 24 and the section 25, through the inlet 26 to the turbo fan unit 27 from which it escapes as a primary air flow through the outlet 30 to the annular passage 37 surrounding the motor shell 32 and cools the outside of the motor. At the same time air is sucked into the motor through the inlet 44 in the sleeve 38 by means of the fan 45 in a counter flow with respect to the air flowing through the annular passage. This cooling air, which is a secondary air flow enters the motor shell via the openings 43 and flows over the the internal parts of the motor thereby effectively cooling bearings, stator and rotor before leaving to the cooling air fan 45 via the openings 42. The cooling air then flows through the outlet 46 into the air flow which is leaving the turbo fan unit. The two air flows are mixed with each other and then flow through the passage 37, the outlet 39 and the filter 40 to atmosphere.

It has also proved to be possible to desist from the blades of the cooling air fan and instead let the rear side of the turbo fan impeller be a mainly flat surface since the friction which is present between the rotating surface and the molecules of the air gases at these high speed is sufficient to throw the molecules towards the periphery so that a cooling air flow is created through the motor.

The device shown in Fig.4 differs from the device which is shown in Fig. 3 only with respect to the cooling air fan which is missing. Instead the passage 37 has a narrow section 47 which together with through openings 48 in the motor shell 31 forms a venturi which sucks cooling air from the inlet 44 via the openings 43 and through the motor. However, this embodiment has the disadvantage that there is no cooling if the primary air flow is blocked which could happen if something clogges the nozzle or tube shaft.

The embodiment shown in Fig. 5 has no separate cooling air fan. Instead the turbo fan impeller 29 is used in order to suck the cooling air from the inlet 44 of the cooling air through the electric motor via one or several channels 49 extending from the inside 35 of the motor shell to a chamber 50 outside the shell part 36 the chamber via one or several openings 51 communicating with the inlet 26 of the turbo fan unit.

In the embodiment shown in Fig. 6 a cooling air fan 52 is used which is placed at the inlet 44 for the cooling air i.e. at the opposite side of the electric motor with respect to the turbo fan impeller. The air is by means of the cooling air fan forced through the electric motor and into the primary air flow through openings 53 in the motor shell.

By means of the suggested arrangements which are illustrated in Figs. 2-3 and 5-6 an effective cooling of the motor is allways achieved at the high speed which is used this cooling effect mainly being independent of the air flow through the nozzle.

Fig. 7 shows an arrangement which is similar to the arrangement shown in Fig. 3 but in which there is a seperate annular deflector plate 54 surrounding the rear part of the impeller 29. The plate 54 is placed at a distance from the motor shell 35 so that a passage 55 is formed through which the cooling air flow from the fan 45 enters into the primary flow in the passage 37 mainly in the same direction as the primary flow. This arrangement has proved to give a considerable increase in the suction power.

Claims

1. Vacuum cleaner device wherein the device is provided with a suction nozzle (14) and a dust bag connected to the nozzle for instance by means of a tube connection (13); a turbo fan arrangement (11) comprising a turbo fan unit (27) driven by an electric motor (32) and placed after the dust bag (12), seen in the air flow direction, the primary air flow created by the turbo fan unit (27) being arranged to directly or indirectly leave the unit via an outlet (39) to atmosphere; first means (45,47,29,52) creating a secondary air flow which at least partly cools the electric motor (32) and which flows into the electric motor (32) via one or several inlets (43) which are separated from the primary air flow, the impeller (29) of the fan unit being driven at a speed which is above 50.000 rpm; second means in the form of openings (46,48,51,53) and/or a deflector plate (54) for directing at least a part of the secondary air flow from the first means (45,47,29,52) into the primary air flow.

2. Device according to claim 1 wherein said first means comprises a fan (45) for cooling air which is

placed at the same side of the electric motor (32) as the turbo fan unit (27), [redacted]n preferably being of the radial type.

3. Device according to claim 2 wherein the fan (45) for cooling air and the turbo fan impeller (29) are an integrated unit.

4. Device according to any of the preceding claims wherein the electric motor is provided with hub parts (41) which support bearings for an electric motor shaft (31), the cooling air inlets (43) to the electric motor being arranged close to one of said hub parts whereas the cooling air outlets (42) from the electric motor are arranged close to the other hub part.

5. Device according to claim 2 wherein the cooling air fan is formed by the mainly flat rear side of the turbo fan impeller (29).

6. Device according to any of the preceding claims wherein it comprises a passage (37) which is so arranged that the primary air flows around the shell (35) of the electric motor (32) whereas the cooling air flow is arranged to counterflow within the motor shell (35).

7. Device according to claim 1 wherein said first means is a venturi (47) in which the primary air flow is the active medium of the venturi and in which the inlet (44) of the secondary air flow communicates with the suction side (48) of the venturi.

8. Device according to claim 1 wherein said first means is the impeller (29) of the turbo fan unit (27) the space within the shell of the electric motor communicating with the inlet (26) of the turbo fan unit via a pipe connection or the like.

9. Device according to claim 1 wherein said first means comprises a fan (52) for cooling air which is placed at the opposite side of the electric motor with regard to the turbo fan impeller (29).

10. Device according to any of the preceding claims wherein said deflector plate (54) directs the secondary air flow from the cooling air fan into the same direction as the primary air flow.

Patentansprüche

1. Staubsaugergerät mit einer Saugdüse (14) und einem Staubbeutel, welcher mit der Saugdüse beispielsweise über eine Rohrstange (13) verbunden ist, **gekennzeichnet durch** ein Turbogebläse (11), umfassend eine Turbogebläseeinheit (27), welche durch einen Elektromotor (32) angetrieben wird und, in Strömungsrichtung der Luft gesehen, hinter dem Staubbeut[redacted]) angeordnet ist, wobei der Primärluftstrom, der durch die Turbogebläseeinheit (27) erzeugt wird, so geleitet wird, daß er aus der Einheit direkt oder indirekt über einen Auslaß (39) in die Atmosphäre austritt; sowie durch eine erste Einrichtung (45, 47, 29, 52), die einen Sekundärluftstrom erzeugt, welcher zumindest teilweise den Elektromotor (32) kühlt, und welcher über einen oder mehrere Einlässe (43), welche vom Primärluftstrom getrennt sind, in den Elektromotor (32) einströmt, wobei das Gebläserad (29) der Turbogebläseeinheit mit einer Geschwindigkeit angetrieben wird, die oberhalb von 50.000 U/min liegt; und durch eine zweite Einrichtung in Form von Öffnungen (46, 48, 51, 53) und/oder einer Leitplatte (54), welche zumindest einen Teil des Sekundärluftstromes von der ersten Einrichtung (45, 47, 29, 52) in den Primärluftstrom leitet.

2. Gerät nach Anspruch 1, **dadurch gekennzeichnet, daß** die erste Einrichtung ein Gebläse (45) für Kühlluft umfaßt, welche auf derselben Seite des Elektromotors (32) angeordnet ist wie die Turbogebläseeinheit (27), wobei das Gebläse vorzugsweise ein Radialgebläse ist.

3. Gerät nach Anspruch 2, **dadurch gekennzeichnet, daß** das Gebläse (45) für die Kühlluft und das Turbogebläserad (29) eine integrale Einheit bilden.

4. Gerät nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** der Elektromotor mit Nabenteilen (41) versehen ist, welche die Lager für die Welle (31) des Elektromotors abstützen, und daß die Kühllufteinlässe (43) am Elektromotor in der Nähe eines der Nabenteile angeordnet sind, während die Kühlluftauslässe (42) aus dem Elektromotor in der Nähe des anderen Nabenteiles angeordnet sind.

5. Gerät nach Anspruch 2, **dadurch gekennzeichnet, daß** das Kühlluftgebläse durch die im wesentlichen flache Rückseite des Turbogebläserades (29) gebildet wird.

6. Gerät nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** dieses einen Durchlaß (37) aufweist, welcher so angeordnet ist, daß der Primärluftstrom um das Gehäuse (35) des Elektromotors (32) fließt, wohingegen der Kühlluftstrom so geleitet wird, daß er innerhalb des Motorgehäuses (35) entgegenfließt.

7. Gerät nach Anspruch 1, **dadurch gekennzeichnet, daß** die erste Einrichtung eine Venturidüse (47) ist, in welcher der Primärluftstrom das

aktive Medium ist, und in welcher der Einlaß (44) des Sekundärluftstr[illegible] Verbindung zur Saugseite (48) der Venturi[illegible]hat.

8. Gerät nach Anspruch 1, **dadurch gekennzeichnet, daß** die erste Einrichtung das Gebläserad (29) der Turbogebläseeinheit (27) ist, und der Raum innerhalb des Gehäuses des Elektromotors Verbindung mit dem Einlaß (26) der Turbogebläseeinheit über eine Rohrverbindung oder dergleichen besitzt.

9. Gerät nach Anspruch 1, **dadurch gekennzeichnet, daß** die erste Einrichtung ein Gebläse (52) für Kühlluft umfaßt, welches in bezug zum Turbogebläserad (29) auf der gegenüberliegenden Seite des Elektromotors angeordnet ist.

10. Gerät nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die Leitplatte (54) den Sekundärluftstrom vom Kühlluftgebläse in derselben Richtung wie den Primärluftstrom leitet.

Revendications

1. Dispositif formant aspirateur, dans lequel le dispositif est muni d'une buse d'aspiration (14) et d'un sac à poussière relié à la buse, par exemple, par l'intermédiaire d'une liaison par tuyau (13) ; un agencement de turboventilation (11) comportant une unité de turboventilation (27) entraînée par un moteur électrique (32) et placée après le sac à poussière (12), dans la direction d'écoulement de l'air, l'écoulement d'air principal créé par l'unité de turboventilation (27) étant agencé pour quitter directement ou indirectement l'unité via une sortie (39) vers l'atmosphère ; des premiers moyens (45, 47, 29, 52) créant un écoulement d'air secondaire qui refroidit au moins partiellement le moteur électrique (32) et qui s'écoule jusque dans le moteur électrique (32) via une ou plusieurs entrées (43) qui sont séparées de l'écoulement d'air principal, la roue (29) de l'unité de turboventilation étant entraînée à une vitesse qui est supérieure à 50000 tours minute ; des seconds moyens ayant la forme d'ouvertures (46, 48, 51, 53) et/ou d'une plaque formant déflecteur (54) pour diriger au moins une partie de l'écoulement d'air secondaire provenant des premiers moyens (45, 47, 29, 52) jusque dans l'écoulement d'air principal.

2. Dispositif selon la revendication 1, dans lequel lesdits premiers moyens comportent un ventilateur (45) pour l'air de refroidissement qui est placé au niveau du même côté du moteur électrique (32) que l'unité de turboventilation (27), le ventilateur étant de préférence du type radial.

3. Dispositif selon la revendication 2, dans lequel le ventilateur (4[illegible]ur l'air de refroidissement et la roue de turboventilation (29) sont une unité formée en un seul bloc.

4. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le moteur électrique est muni de parties de moyeu (41) qui supportent des paliers pour un arbre de moteur électrique (31), les entrées d'air de refroidissement (43) vers le moteur électrique étant agencées à proximité d'une desdites parties de moyeu alors que les sorties d'air de refroidissement (42) depuis le moteur électrique sont agencées à proximité de l'autre partie de moyeu.

5. Dispositif selon la revendication 2, dans lequel le ventilateur d'air de refroidissement est formé par le côté arrière pratiquement plat de la roue de turboventilation (29).

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel il comporte un passage (37) qui est agencé de sorte que l'air principal s'écoule autour de l'enveloppe (35) du moteur électrique (32) alors que l'écoulement d'air de refroidissement est agencé à contre-courant dans l'enveloppe de moteur (35).

7. Dispositif selon la revendication 1, dans lequel lesdits premiers moyens sont un venturi (47) dans lequel l'écoulement d'air principal est le milieu actif du venturi et dans lequel l'entrée (44) de l'écoulement d'air secondaire communique avec le côté d'aspiration (48) du venturi.

8. Dispositif selon la revendication 1, dans lequel lesdits premiers moyens sont la roue (29) de l'unité de turboventilation (27), l'espace situé dans l'enveloppe du moteur électrique communiquant avec l'entrée (26) de l'unité de turboventilation via une liaison par tuyau ou analogue.

9. Dispositif selon la revendication 1, dans lequel lesdits premiers moyens comportent un ventilateur (52) pour l'air de refroidissement qui est placé au niveau du côté opposé du moteur électrique par rapport à la roue de turboventilation (29).

10. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ladite plaque formant déflecteur (54) dirige l'écoulement d'air secondaire provenant du ventilateur d'air de refroidissement dans la même direction que l'écoulement d'air principal.

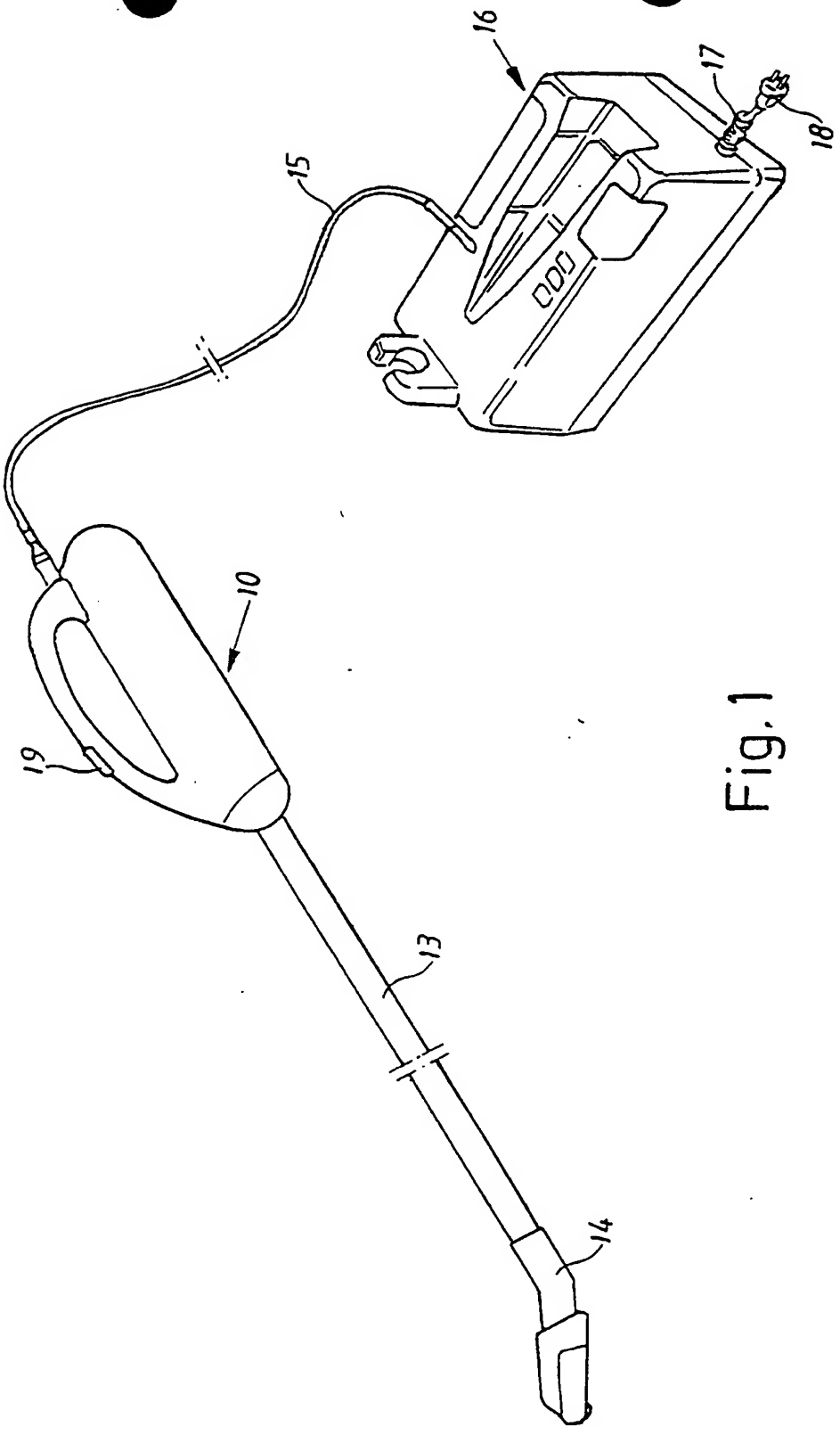

Fig. 1

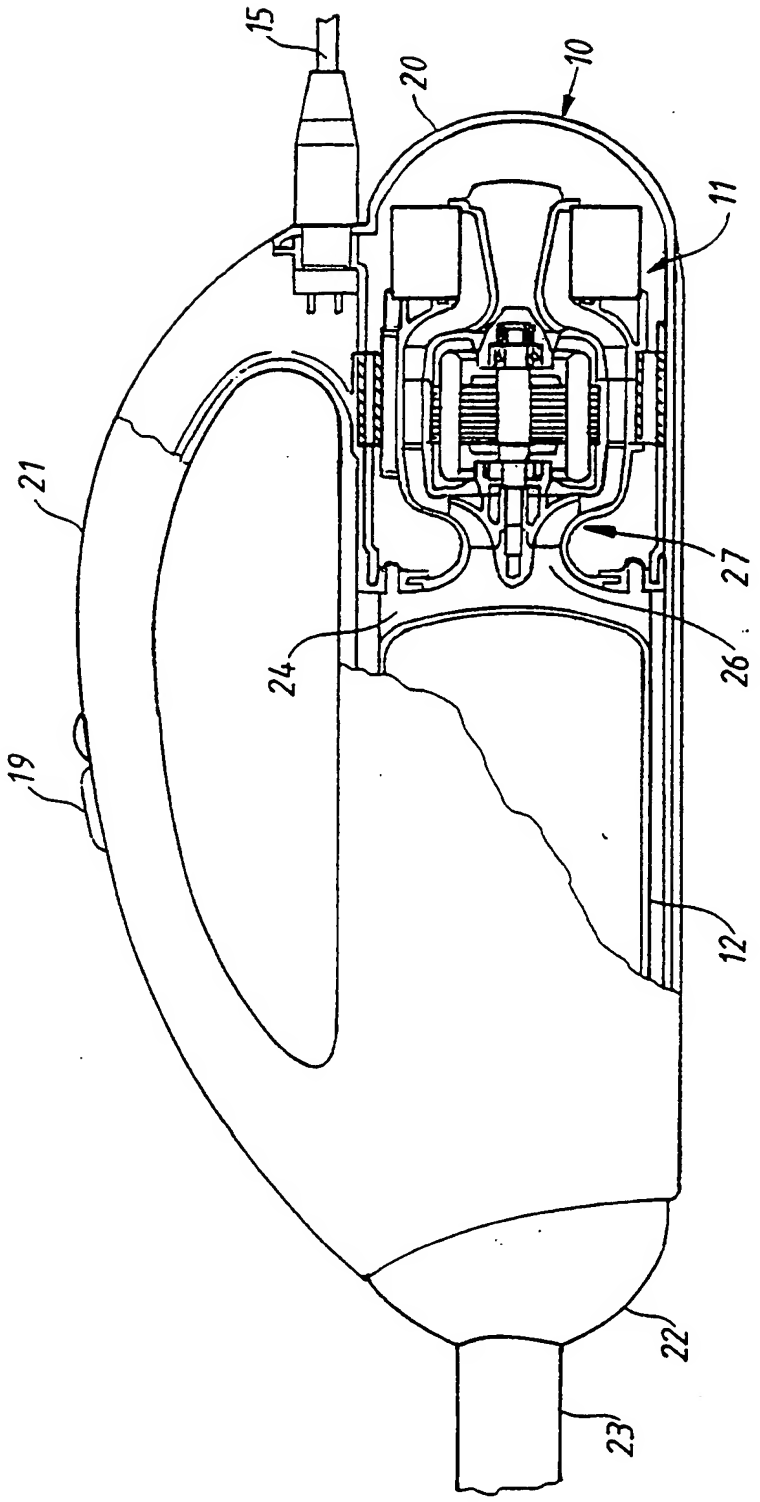

Fig.2

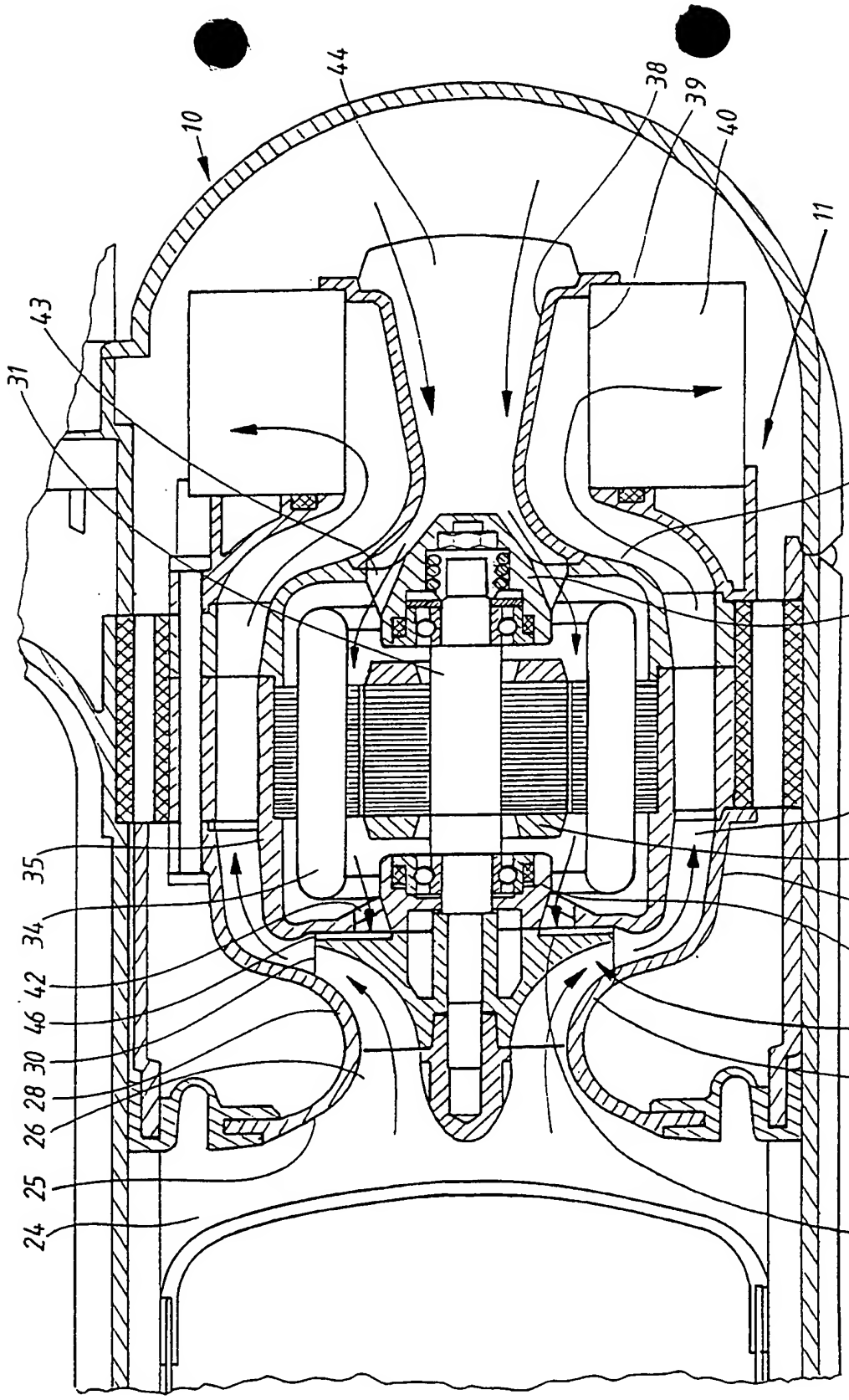
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Fig. 3

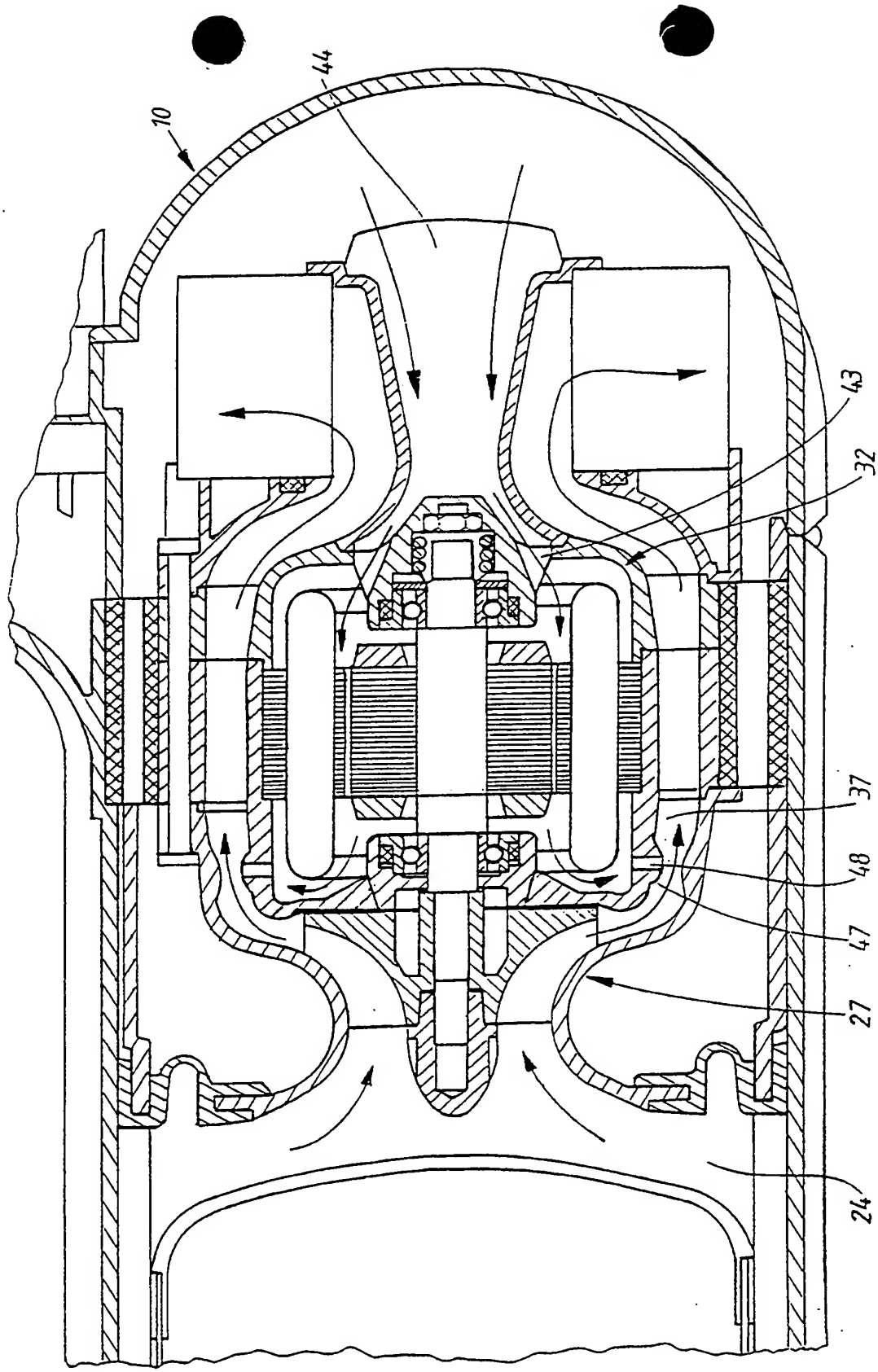

Fig. 4

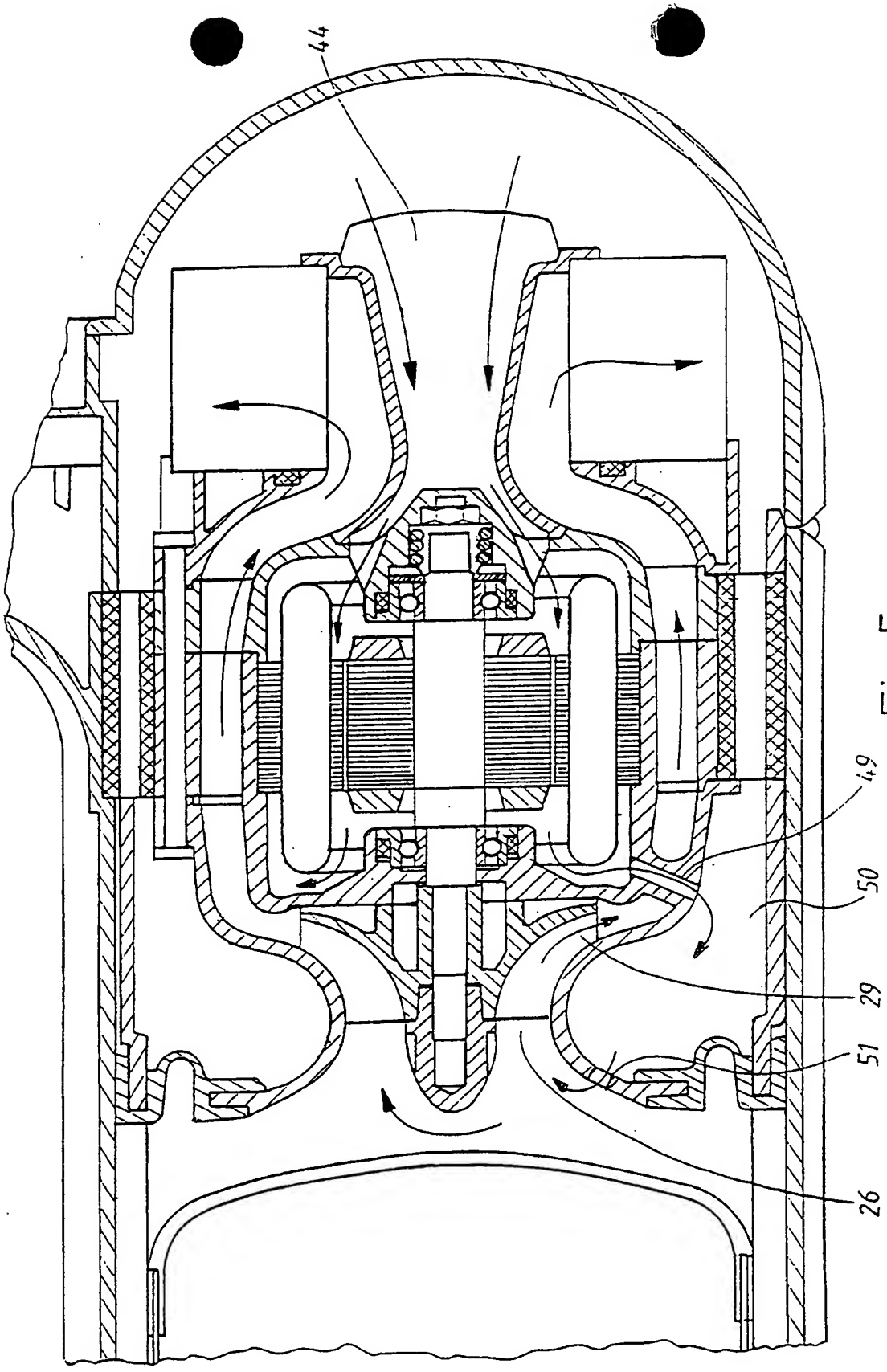

Fig.5

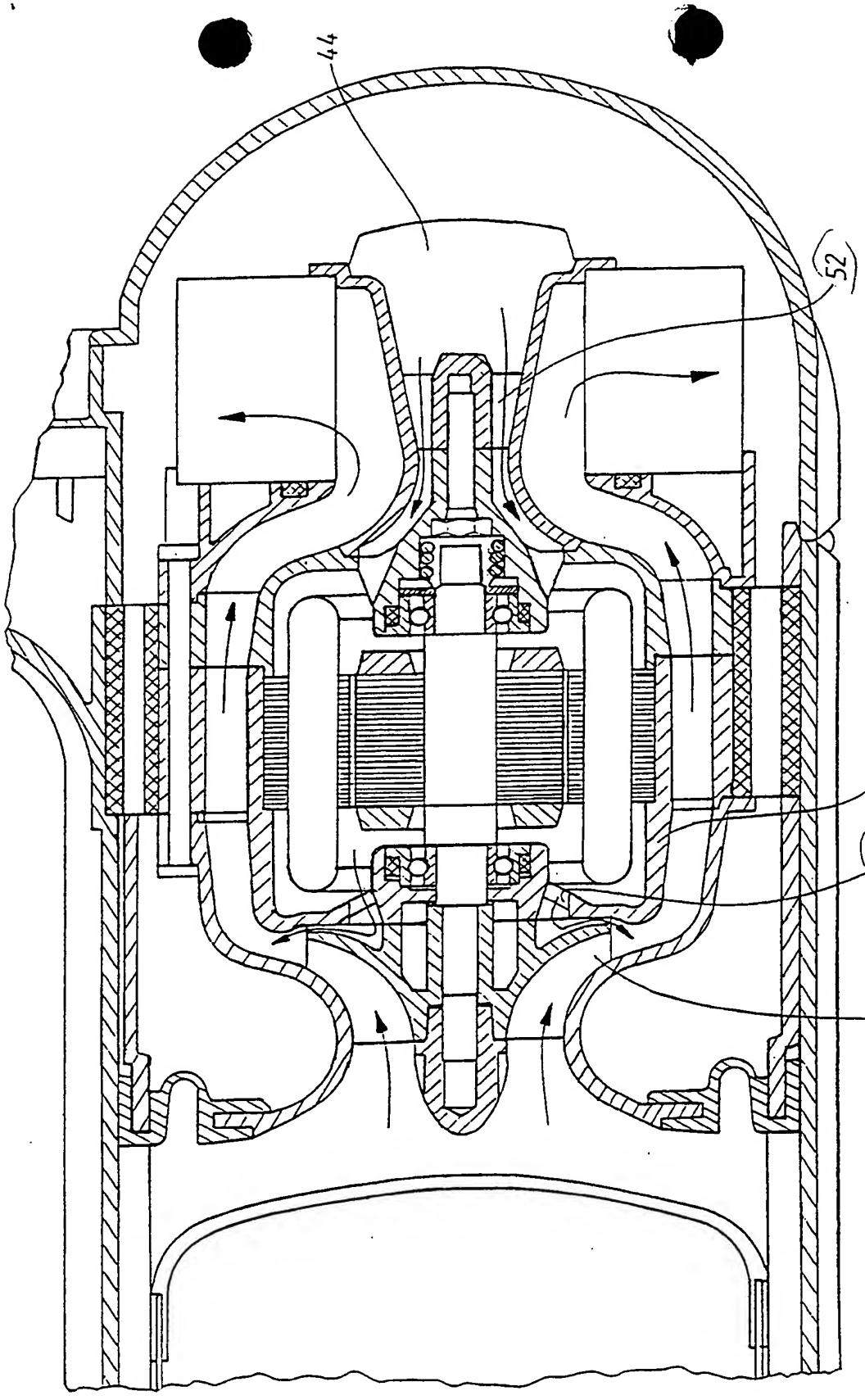

Fig.6

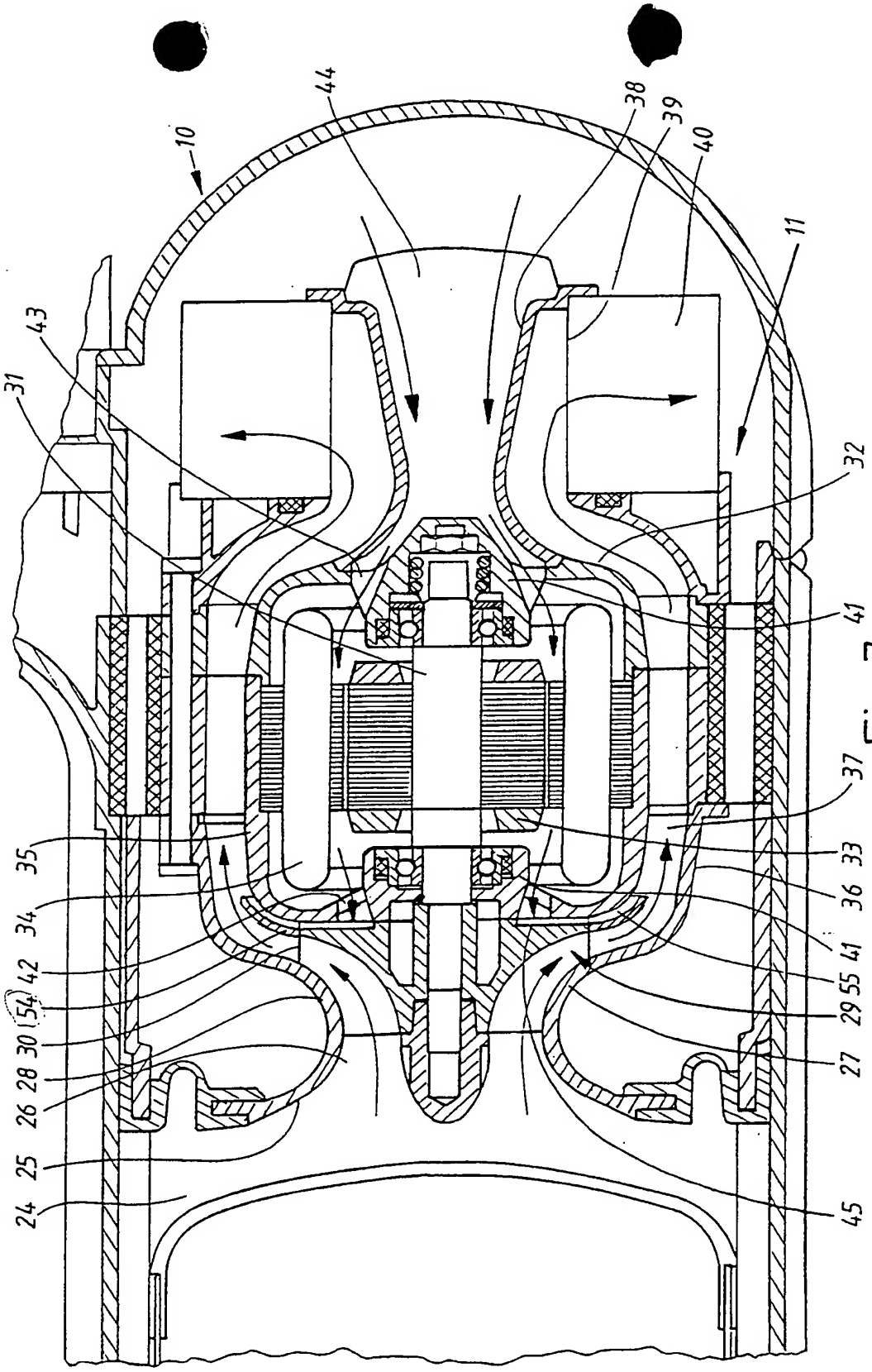
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Fig. 7